DEVELOPING LAND INFORMATION MANAGEMENT SYSTEM (LIMS) FOR COUNTY GOVERNMENTS IN KENYA: A CASE STUDY KIRINYAGA COUNTY.

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Abstract

This paper describes the development of a Land Information Management System (LIMS) for County Governments in Kenya. In the new Constitution 2010, devolution of some national government functions and formation of county governments was provided for. These invoked the development of new land laws to guide the devolution processes and procedures. According to the County Government Act 2012, all County Governments are supposed to develop digital Geographic Information System (GIS) based spatial plans and these calls for development of LIMS for and efficient breakthrough.

The LIMS development involves accessing manual land records that have variety standards and inoperable from different sources, digitization of all the available data, flying Unmanned Aerial Vehicle (UAV) where adjudication process has not taken place and no cadastral maps exists and then developing a database of the same. In this regard, there is need to study the development of LIMS for Kirinyaga County Government so as to give other developers of various county governments in Kenya, a know how in future LIMS development initiatives. This paper uses case study methodology to document the development of a LIMS for Kirinyaga County in Kenya.

KEY WORDS: Land Information Management system, Kenya and County Governments.
Introduction

The constitution on Kenya 2010 introduced devolution and formation of the 47 county governments. The enactment of new land laws and the Kenyan constitution 2010 enhanced devolution and a need for digital LIMS and this resulted in the subsequent overhaul of Land Laws to conform to the provisions of the Constitution. Chapter 5 (Land and Environment) and 11 (Devolution) of the constitution of Kenya 2010 have established the structure of Land Management, the County Governments being one of them. Every county government is expected to support land management at the county level.

In Kenya, the National Land Commission and the Ministry of Land and Physical Planning are charged with the mandate of Land Management and Administration. In 2013, the National Land Commission was formed to act as the lead agency in land matters, working with the Ministry of Land and Physical Planning and county-level institutions. The strategic focus areas of National Land Commission are: Devolution of Land management to the county level, land registration, natural resource management, National Land Information Management System and resolution of land-related disputes. Devolved resource management is the principle of delegating policy-making in resource management to the lowest effective local levels of public authority.

The National Land Commission Act of 2012, section 5 (2) (d) mandates the National Land Commission with the task of developing and maintain a nationwide Land Information Management System at both national and county levels to help streamline operations and management of land in Kenya. To help the Commission in this quest, the National Land Information Management System (NLIMS) directorate was formed.

The County Government Act of 2012 Laws of Kenya requires that a county planning unit be responsible for ensuring the collection, storage and updating of data and information suitable for the planning process and ensuring the establishment of a GIS based Database system. The spatial plans and the GIS Database system are a source of LIMS which enables proper land planning and management.

The Land Act no. 6 of 2012 Laws of Kenya Section 8(a) on Management of Public Land provides that the National Land Commission on behalf of National and County Governments
shall identify public land, prepare and keep a database, geo-referenced and authenticated by Survey Department and share data with the public and relevant institutions. Section 6 of the same Act provides that the Cabinet Secretary shall develop policies on land, facilitate the implementation of land policy reforms, coordinate the management of National Spatial Data Infrastructure, coordinate the formulation of standards of service in the land sector and regulate service providers and professionals to ensure quality control.

Since the National Land commission has not yet provided the counties with the digital data; these calls for the counties to come up with a Land Information Management System (LIMS) as a base towards preparing the spatial plans for the counties.

The practice and management of land in Kenya is currently challenged by the fact that all records are manual, voluminous and hence vulnerable to wear and tear, loss of records and missing files, fraudulent and illegal alterations, while at the same time some data is illegible.

**Land Information Management Systems (LIMS)**

Land Information Management System (LIMS) is a system that comprises of subsystems that supports all processes like the land ownership and rights and restrictions, registration, tax, value, use and land laws that are normally encountered in land administration and management of a particular land parcel.

In Kirinyaga County, the county department of Land, Housing and Urban Development resolved to make the development of LIMS a flagship project for the financial year 2015/2016 so as to fulfill the legal requirements and to provide an accurate basis for the development of the County for the next ten years. The Technical University of Kenya (TUK) agreed to undertake this project for the Kirinyaga County, on a Public to Public Partnership basis and drew a Memorandum of Understanding for the same.

The County LIMS will help in reducing corruption, unnecessary bureaucracy through streamlining and putting in place appropriate processes and procedures when all the services will be in an electronic platform. The services will be accessible from the comfort of the citizens’ homes and offices without having to visit the public institutions through use of the computers.
and mobile devices. Land transactions will be secure, transparent and straightforward and once completed will reflect the correct status of a parcel in the LIMS and on the ground.

By converting and holding data on land parcels, ownership, production, costs and uses in digital form, this data is safeguarded to a greater extent from loss or damage hence reduction of risk. Having collected existing data, and integrating the data with other data topics and layers, more useful information will be produced to support decision making and tracking, which in turn supports greater efficiency in use of all land resources. For example, forestry production, land and building leasing and rental and agribusiness planning all benefit from LIMS implementation hence ensuring enhanced efficiency of resource use.

Building on the integration of relevant data, and use of key land map layers such as topography and transport, it is possible to model and analyses scenarios of land usage. LIMS leads to effective and efficient Analysis and Reporting Possibilities for sharing data and results of analyses greatly increase with access to integrated data holdings augmented by mapping information systems.

**Development of LIMS**

The Kirinyaga county LIMS was developed with an aim of combining all the land information and putting it into one electronic platform. The development process of Land Information Management System (LIMS) begins from the signing of Memorandum of Understanding. Development Kirinyaga County LIMS involved user need evaluation, collection of data, system development and system implementation. The user need evaluation involved getting views of different users and stakeholder on the data that they need like and how they need it.

A field reconnaissance to determine the extent of the area of study and identify details within the area of study was done. There was user need assessment where the users of the system, their information needs and the data that was needed to cater for the user needs was accessed. During LIMS development a stakeholder engagement to have a common understanding with those who have vested interest in the set-up of the system is undertaken. As a result of inclusive contribution, the users get a sense of ownership.
An innovative thinking using technology to address the needs of the users of LIMS using hardware and software to be used for the system to be efficient without any unnecessary data redundancy that can be a poor match for its user requirements. The data was collected in a correct manner and stored in the correct format.

The collected data was normalized and design of the relational tables as per the attributes, entities and relations identified during conceptual modeling. The analogue data and raster maps were converted to digital data and vector maps systematically.

The final level was both hardware and software dependent where the data was stored and efficiently accessed. There was testing and querying of the data with actual implementation of the logical flow in a system. The Land Information Management System is then functional and continuously updated to be up to date and real-time for every user accessibility and use.

Checking the readiness and accuracy of the system to access, update and retrieve data from new files is done to locate and correct errors in the program. A Parallel run is conducted, for both new and old systems simultaneously, providing added assurance against errors in the new system and gives Users staff an opportunity to gain experience is done during implementation phase. The system is adjusted to changes created by the new system evaluation and maintenance, hardware and software periodic checks. If new information is inconsistent with the design specifications, and then changes have to be made.

Land Information Management System (LIMS) is a customized database management system for land. There is a three-level American National Standards Institute (ANSI) Standards Planning and Requirements Committee (SPARC) architecture that was adopted by Connolly and Begg (Thomas Connolly and Carolyn Begg, 2005) that was adopted. The diagram bellow shows the levels of database development, it is important because it shows all the stages that are involved in Kirinyaga county LIMS development.
The external level is the first stage of LIMS development that involves the user need assessment, where the users of the system, their information needs and the data that is needed to cater for the needs are determined. The user need assessment was done by stakeholder’s engagement and questioner administration to get the entities, attributes and relationships in Kirinyaga land information management system that the users are interested in.

During user needs assessment and data collection the users of the system were involved in identification of boundaries, extents of encroachment and even the development pattern. Adoption of participatory mapping helped in making the users feel part of the system and even owning it.

For effective and efficient data collection an external data model for Kirinyaga County was developed. The external data model shows what data needs to be collected and from which source. The real world being Kirinyaga County has users who need different information from a
land parcel, that has its attributes and spatial information as shown in figure 2 below. The external data model makes attribute data collection and keying in excel efficient and effective hence saving on time.

Figure 2: External model

In the external data model above shows different users and stakeholders in Kirinyaga County and different information about land that they need within a click of a button when the LIMS is developed.
Data collection

The data collection involved getting all the available administrative data that the users of the LIMS system needed and digitizing it. The attribute data was collected from the department of Land and Housing of Kirinyaga County, land records office; the former municipal council office and the district land registry in Kirinyaga County. The spatial maps were from the Survey of Kenya in Ruaraka, the district survey office in Kerugoya Town, the Kirinyaga ministry of land and housing survey department and land owners for the amendments maps.

The data collected to develop a Land Information Management System is based on the conceptual model of database development. Data collection involves digitizing all the available Part Development Plans (PDPs), registry index maps (RIMs) and fixed survey maps, and collection of attribute data about ownership and tenure details of the Land parcels. The collected data and the digitized maps are used to develop a database for LIMS using Arc Map. The digitization aids in formation of the base map that guides in the collection of attribute data that is related to parcel. The Land as a factor of production can only be presented in this system as parcels. The parcels give the location and area thus providing link between the spatial information (location) and developments.

Attribute data

To develop the attribute table, Microsoft Excel was used based on the external data model attributes data needed by different parties. In the Excel sheet, columns were created and the data entered. The GIS stores both spatial and non-spatial data in a database system which links the two types of data to provide flexible and powerful ways of querying or asking questions about the data. Attribute data collection was done by direct keyboard data entry in customized MS excel spreadsheet. The attribute data collection was from the county department of land and housing archive for leasehold land parcels and land registry for freehold land parcels.
Figure 3: Kirinyaga County Registered leaseholds

Attribute data of Kirinyaga County registered leasehold land was from both the county land registry in Kerugoya Town and Kirinyaga Ministry of Land and Housing, records office. The registered leaseholds have a certificate of Lease in place and parcel numbers. The above table shows the information about the leasehold parcel, the lease term, current owner details and the encumbrances.

Figure 4: Registered freeholds

The attribute data on Kirinyaga County registered freehold land was collected from the Land Registry in Kerugoya Town. The above table shows the information about the land parcels,
owners from the original owner to the current, the different subdivisions that brought about new parcel numbers and the encumbrances.

Figure 5: Unregistered from the Former Municipal Council files

The table above shows the owner details, the allocation number, size of the parcel, ownership document and the lease period for the unregistered leasehold parcels.

Spatial data

During development of the Kirinyaga county LIMS, the digitized cadastral maps were georeferenced and overlaid over each other and with the Google images of the area. These helped in showing that the developments on the ground are not in line with the proposed planning.

The spatial data which were the cadastral maps were in analogue paper form and had to be digitized. The digitized cadastral maps were the part development plans (PDPs), RIMs and fixed survey maps. Digitization was by scanning and saving it as a Jpeg, in Arc map the image was added, in the data frame properties UTM Arc 1960 37s was chosen, in georeferencing control points were added at least 4 coordinate points were chosen, in the Arc catalogue boundary and shape file as polygon was added and tracing of boundaries and parcels and inserting the parcel
numbers using Arc map. The spatial data collection involved the digitization of all available cadastral plans.

**Digitization of the Physical Development Plan (PDP)**

PDPs are obtained from the physical planning department offices in the county. The PDPs are mainly used as the base information since they contain the current information that is being used by the former municipal councils. The PDPs are digitized and overlaid over the cadastral maps i.e. fixed survey plans and the RIMs.

**Figure 6: Digitized PDP, Part of Kirinyaga County**
Digitization of the registry index maps (RIMs)

A registry index map (RIM) is used for general boundary land registration under Registered Land Act (CAP 300) laws of Kenya. The Registry Index Maps shows the general boundary. With the general boundary, the exact location of the boundary is undetermined but assumed to be represented by a visible physical feature such as hedges, rivers or streams or any physical feature that may be found suitable for the definition of the position of the boundary. The Registry Index Maps are generated from non-rectified aerial photographs hence the areas of the land parcels and the shapes are not ground accurate. In order to convert the existing RIMs into digital format the analogue maps were scanned, georeferenced and tracing of the boundary lines. RIMs are obtained from the district survey offices or from the survey of Kenya headquarters.

Figure 7: Digitized RIM, a part of Kirinyaga County

Digitization of the cadastral plans/Fixed Survey Maps

A fixed survey map is a map for the fixed boundaries. The fixed cadastral plans are obtained from Survey of Kenya headquarters in the cadastral section. The plans are in Universal traverse Mercator (UTM Arc 1960 Datum) Projection. The required FRs within Kirinyaga County towns are identified from fixed general RIM map and taken for search. Features such as land parcels, typically provide the results on a survey plan that describes the location of features relative to each other. The plans are drawn in ArcGIS environment through Coordinate Geometry (COGO). The list of coordinate are feed in excel and the exported to the Arc Map. These coordinates prove
the controls that are used to construct the lines. COGO provides means of drawing parcels by feeding the bearing and distances.

**Figure 8: Digitized Fixed Survey, A Part of Kirinyaga County**

**Conceptual level**

This level describes what details stored in the database and the relationships among the data. The conceptual level supports each external view, in that any data available to a user must be contained in or derivable from the conceptual level. A model is developed that conceptualizes the part of the real world which is relevant for a specific application [Coronel et al., 2011). The entities relationships and attributes were identified and a conceptual data model was built which is an entity relationship model that was created using DIA.

DIA is open source software that is used in drawing diagrams with entities and relationships as for Kerugoya LIMS. The entity-relationship model was a check for redundancy and conceptual model Validation against user needs and to achieve accurate representation of the data, relationships between the data, and constraints on the data that is pertinent to the enterprise. Kirinyaga County entity-relationship model is as shown below.
Figure 9: Entity-Relationship model of Kirinyaga County

In Kirinyaga LIMS, land parcel and its information is the main concern. In the entity-relationship model above land parcel has information on use, value, location, address, tenure type, registration Act, development zone, owner details acreage and parcel id. The relationship between the owner and land parcel is many-to-one (n-1). Parcel owner can have a lease or not, on the land parcel the is a property for rent that is rented by many tenants (1-n) and the property can be used by owner only, where there can be many properties owned jointly or in shares by many owners (n-n) in a land parcel. Parcel owner lives in a neighborhood that has a development zone, a name and details about crime or flooding. The land parcel is conveyed by a lawyer who is interested in name of the owner, type of tenure in the land, address, parcel id and the registration Act, the land parcel-lawyer relationship is one-to-many(1-n).
The land parcel is administered by the Kirinyaga County government Ministry of Land and Housing, many land parcels are administered by one ministry of land and housing (n-1). Land parcel information (address value and parcel id) is needed by taxman. The Kirinyaga Ministry of Land has surveying department that needs the land parcel (location, acreage, coordinates, and parcel id), valuation department that needs details on value, acreage, address, parcel id and physical planning department that is interested on details about development zone, address, parcel id and location. The relationship between the Kirinyaga ministry of land and housing and the departments is one-to-one (1-1). In the spatial database the land parcel is bounded by arc that consists of points defined by coordinates.

**Logical level**

The conceptual data model was translated to logical data model and validated to check that it is structurally correct and able to support the required transactions. To represent the entities, relationships and attributes relations were derived for logical data model. The relationship that an entity has with another entity was represented by the primary key (parcel id)/foreign key mechanism (Thomas Connolly and Carolyn Begg, 2005). The relations of the logical data model were validated by normalization to ensure that each relation is structurally correct and duplication does not happen. The logical model was validated by the users, integrity constrains checked and the model was checked for future accommodation of changes.

Normalization was achieved by examining the relationships between attributes by using a series of tests (normal forms) to help identify the optimal grouping for these attributes to ultimately identify a set of suitable relations that supports the data requirements of the LIMS database, normalization of the Excel tables is imported in Access. In the normalized table, all the entries have the same font and format.

**Physical Level**

The data was organized physically. The relational database schema from the logical data model that was be implemented in the LIMS is produced. A translation of the relations in the logical data model into a form that can be implemented in the LIMS relational database management system by designing a base relations, designing representation of derived data and designing
general constrains. Then a file organizations and indexes are determined by analyzing transactions, choosing file organizations, choosing indexes and estimating disk space requirement (Thomas Connolly and Carolyn Begg, 2005).

To develop a life cycle the user view that was identified during the external level is designed and documented. A security mechanism for the Kirinyaga County LIMS database is designed as specified by the user during user need assessment. This level is managed by the operating system under the direction of the database management system.

**Findings.**

So far the Kirinyaga County pilot project on Land Information Management System is still being implemented phase by phase. All the available Land information for the major towns has been digitized and a database system has been developed. Some other County Governments in Kenya are in the process of developing their Land Information Management Systems.

When developing Kirinyaga county LIMS the spatial data on some of the plots was unavailable especially Wang’uru area because the adjudication process has not taken place yet; so there was no spatial data available for use. The developer saw the need to use a UAV to fly the area and generate the orthorectified images then adjust the spatial boundary and get RIMs for the area. These is a more effective, efficient and timely way out of getting these RIMs than waiting for the adjudication process to be undertaken by the Kenyan government that can take years before the final output is seen. Using UAVs will lead to faster completion and implementation of the Kirinyaga county LIMS.

During the development of Kirinyaga County various challenges were encountered which included the legal, political, social, technical and economic challenges. These challenges are based on the driving forces of attaining a sustainable development and sustainable Land Information Management System.
Conclusion

In order to achieve the sustainable development, it is vital for every county to develop Land Information Management System. Owing to the fact that the county resources are based on land, there is the need to have a system that integrates all the information on the resources within the county. With this system in place the Counties will improve economically, politically, socially and environmentally. This is because LIMS provides a better platform for decision making on the use of the resources.

LIMS is needed to prevent wastage of scarce resources especially in the third world countries, hence an essential for sustainable land administration that leads to good governance (Mclaughlin, 1988). Without an appropriate Land Information Management System Counties will not be able to deliver at scale the expected economic and social services to people in these areas, and they will not be able to offer sustainable and affordable tenure security to the majority. They will also not be able to increase the governance and transparency of the land system through decentralized systems of land management using local record offices as part of the Land Information Management System (UN-Habitat, 2003).

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